

Title: Feature Presentation: Data Analysis, Starring Box-and-Whisker Plots

Brief Overview:

In this unit students will use movie statistics to determine measures of central tendency and measures of variation. They will also construct box-and-whisker plots manually and with a graphing calculator. Finally students will analyze data by comparing the measures of central tendency, the measures of variation, and double box-and-whisker plots.

NCTM 2000 Principles for School Mathematics:

- . **Equity:** *Excellence in mathematics education requires equity - high expectations and strong support for all students.*
- . **Curriculum:** *A curriculum is more than a collection of activities: it must be coherent, focused on important mathematics, and well articulated across the grades.*
- . **Teaching:** *Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well.*
- . **Learning:** *Students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge.*
- . **Assessment:** *Assessment should support the learning of important mathematics and furnish useful information to both teachers and students.*
- . **Technology:** *Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning.*

Links to NCTM 2000 Standards:

. **Content Standards**

Data Analysis and Probability

Students will find, use, and interpret measures of center and spread, including mean, median, mode, range, and interquartile range. Box-and-whisker plots will be constructed and analyzed. Observations will be made about differences between two sets of data and conclusions drawn based on the observations.

. **Process Standards**

Reasoning and Proof

Students will analyze sets of data and make comparisons of multiple sets of data to make conjectures.

Communication

Students will use the language of mathematics to describe generalizations and characteristics of a data set and to compare two sets of data.

Grade/Level:

Grades 6 through 8, all levels

Duration/Length:

Five class periods.

Prerequisite Knowledge:

Students should have working knowledge of the following skills:

- . Reading data from a stem-and-leaf plot
- . Computation with whole numbers and decimals
- . Basic calculator skills

Student Outcomes:

Students will:

- . Determine measures of central tendency (mean, median, and mode).
- . Determine measures of variation (range and interquartile range) and outliers.
- . Construct box-and-whisker plots manually and using a graphing calculator.
- . Analyze box-and-whisker plots.

Materials/Resources/Printed Materials:

- . TI-83 overhead calculator with view screen
- . TI-83 graphing calculator per student
- . Rulers
- . 2 pieces of rope, yarn or string
- . Fabric strip
- . 5 signs (Lower Extreme, Upper Extreme, Lower Quartile, Upper Quartile, and Median)

Development/Procedures:

Day 1: Determine the measures of central tendency.

- . Motivate the students by showing a short video clip of an appropriate movie such as *The Grinch Who Stole Christmas* or *Monsters Inc.*
- . Collect data from the students on the number of movies they watched in the past month, either at home or at the movie theatre. Display a list of these numbers on the chalkboard.
- . Use the data set collected above to demonstrate how to find the mean, median, and

mode.

- . Have the students complete *Activity 1 “A Day at the Movies.”* Instruct the students to work in pairs to compare their answers.

Day 2: Determine the measures of variation and outliers.

- . Display a transparency of *Teacher Resource 2, “Top 25 All Time Highest Grossing Movies.”* Instruct students to find the measures of central tendency for this data set as a review/warm up activity.
- . Use the following questions to generate a discussion about the data represented in the table, *“Top 25 All Time Highest Grossing Movies”*:
What was the least amount of money grossed of the top 25 highest grossing movies? (242 million)
What was the greatest amount of money grossed? (601 million)
What is the difference between these two amounts? (359 million)
- . Introduce measures of variation as another way to describe data. Explain to the students that the range and the interquartile range describe the spread of a data set.
- . Instruct the students on how to find the range, upper and lower quartiles, interquartile range, and outliers.
- . Have the students find the measures of variation and outliers for the data on the movies.
- . Instruct the students to use the data from Activity 1 to practice finding the measures of variation and outliers.

Day 3: Construct box-and-whisker plots.

- . Construct a human box-and-whisker plot using the shoe sizes of 11 student volunteers in the class. Refer to *Teacher Resource 3* for directions.
- . Guide the class in constructing a box-and-whisker plot for *Activity 2, “It’s Show Time,”* G-rated movies, following the steps as outlined.
- . Instruct students to follow the same steps to construct a box-and-whisker plot of the running times of PG-rated movies on the same plot.
- . Discuss what portion of the data is represented in each part of the box-and-whisker plot to prepare for analyzing box-and-whisker plots in the next lesson.

Day 4: Use the graphing calculator to construct and analyze box-and-whisker plots.

- . Use the data from *Activity 2, “It’s Show Time,”* to create a box-and-whisker plot of G-rated movies on the TI-83 graphing calculator. Have the students follow along with the steps from *Activity 3, Box-and-Whisker Plot Directions on the TI-83 Graphing Calculator* as the steps are demonstrated with the TI overhead view screen.
- . Have the students construct the box-and-whisker for the running times of PG-rated movies using List 2 and Plot 2 in the graphing calculator.
- . Generate a discussion comparing the two box-and-whisker plots. Focus on the five points of data and how they differ for each type of movie. Ask students what generalization they can make about the running times of G-rated versus PG-rated movies based on the double box-and-whisker plot. Discuss how outliers effect the measures of central tendency.

Performance Assessment:

Distribute rulers and graphing calculators to the students. Have the students complete “*And the Winner Is . . .*” as a final assessment for this unit.

Extension/Follow Up:

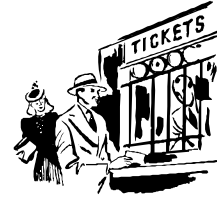
- . Instruct students on how to find the measures of central tendency using the statistics feature on the graphing calculator after day 1.
- . Take students to the internet computer lab to research other interesting movie data. Have students share their findings with the class after summarizing the data using the measures of central tendency and the measures of variations. Possible research topics could include the top ten highest grossing movies for the current year, an update on the top 25 all time highest grossing movies, or a comparison of the ten highest grossing movies for the current year to a previous year.
- . Invite an NSA Mathematics Speaker to present “How to Lie With Statistics.”

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A DAY AT THE MOVIES



Find the mean, median, and mode. Show your work.

- 1.) Mega Cinema kept track of the number of popcorn boxes sold each day over a two-week period of time.

The results were: 42, 26, 36, 19, 98, 107, 56, 36, 72, 84, 23, 87, 124, 67

Mean: _____

Median: _____

Mode: _____

- 2.) A movie like *Harry Potter* appeals to people of all ages. A theater recorded the ages of the first 15 people to arrive at the noon show.

The results were: 40, 6, 5, 19, 38, 27, 9, 16, 8, 23, 47, 74, 7, 5, 6

Mean: _____

Median: _____

Mode: _____

- 3.) The number of tickets sold at your local movie theater was recorded over a 10-day period. The results were: 142, 226, 135, 159, 398, 707, 96, 136, 145, 152

Mean: _____

Median: _____

Mode: _____

- 4.) Mega Cinema has 13 theaters, each showing a different movie. An employee counted the number of previews for each movie:

The results were: 2, 3, 4, 3, 3, 4, 2, 3, 2, 4, 5, 2, 5

Mean: _____

Median: _____

Mode: _____

A DAY AT THE MOVIES ANSWER KEY



Find the mean, median, and mode. Show your work.

- 1.) Mega Cinema kept track of the number of popcorn boxes sold each day over a two-week period of time.

The results were: 42, 26, 36, 19, 98, 107, 56, 36, 72, 84, 23, 87, 124, 67

Mean: $\frac{877}{14} = 62.6$

Median: $\frac{56 + 67}{2} = \frac{123}{2} = 61.5$

Mode: 36

- 2.) A movie like *Harry Potter* appeals to people of all ages. A theater recorded the ages of the first 15 people to arrive at the noon show:

The results were: 40, 6, 5, 19, 38, 27, 9, 16, 8, 23, 47, 74, 7, 5, 6

Mean: $\frac{330}{15} = 22$

Median: 16

Mode: 5 & 6 (bimodal)

- 3.) The number of tickets sold at your local movie theater was recorded over a 10-day period. The results were: 142, 226, 135, 159, 398, 707, 96, 136, 145, 152

Mean: $\frac{2296}{10} = 229.6$

Median: $\frac{145 + 152}{2} = 148.5$

Mode: no mode

- 4.) Mega Cinema has 13 theaters, each showing a different movie. An employee counted the number of previews for each movie:

The results were: 2, 3, 4, 3, 3, 4, 2, 3, 2, 4, 5, 2, 5

Mean: $\frac{42}{13} = 3.2$

Median: 3

Mode: 2 & 3 (bimodal)

Top 25 All Time Highest Grossing Movies
(as of June 2002)

Total Gross (in \$millions)	Movie	Year Released
601	Titantic	1997
461	Star Wars	1977
435	*E.T.	1982
431	Star Wars: The Phantom Menace	1999
370	*Spider-Man	2002
357	Jurassic Park	1993
330	Forest Gump	1994
318	Harry Potter and the Sorcerer's Stone	2001
313	The Lion King	1994
311	The Lord of the Rings: The Fellowship of the Ring	2001
309	Return of the Jedi	1983
306	Independence Day	1996
293	The Sixth Sense	1999
290	The Empire Strikes Back	1980
285	Home Alone	1990
268	Shrek	2001
260	Jaws	1975
260	How the Grinch Stole Christmas	2000
255	*Star Wars: Attack of the Clones	2002
255	*Monsters, Inc.	2001
251	Batman	1989
250	Men in Black	1997
246	Toy Story 2	1999
242	Raiders of the Lost Ark	1981
242	Twister	1996

*Indicates the movie was still in release as of June 2002.

Human Box-and-Whisker Plot

Materials Needed:

2 pieces of rope, yarn or string (each at least 5 feet long)

Fabric strip (about 1 foot wide and about 3 yards long)

5 signs labeled: Lower Extreme, Lower Quartile, Median
Upper Extreme, Upper Quartile

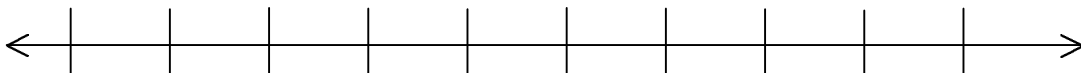
- 1.) Draw a number line from 2 to 11 across the front chalkboard counting by 0.5.
- 2.) Ask for 11 student volunteers to stand under the number that represents their shoe size.
- 3.) Pass out the 5 signs to students who are still sitting in their seats.
- 4.) Have the student with the “Lower Extreme” sign stand and give the sign to the student with the smallest shoe size.
- 5.) Have the student with the “Upper Extreme” sign stand and give the sign to the student with the largest shoe size.
- 6.) Starting at the extremes, have the students step forward in pairs towards the middle person. Ask for the student with the sign “Median” to stand up and give the sign to the student in the front of the room who represents the median of the data. Discuss how the median divides the data into halves.
- 7.) Repeat step 6 for the students below the median to find the lower quartile and then for the students above the data to find the upper quartile. Discuss that now the data is divided into fourths.
- 8.) Box in the students who represent the middle 50% ($\frac{1}{2}$) of the data by having these students hold up the fabric to connect the lower quartile with the upper quartile.
- 9.) Use the rope to represent the whiskers, the lower and upper 25% ($\frac{1}{4}$) of the data. One rope should be held by the lower extreme and connect to the lower quartile and the other rope should be held by the upper quartile and upper extreme.
- 10.) To introduce the students to the concept of outliers, discuss with the class whether or not there are any students who have a shoe size much larger or much smaller than the other students.

IT'S SHOW TIME
Constructing Box-and-Whisker Plots

G-RATED MOVIES	RUNNING TIME (min)	PG-RATED MOVIES	RUNNING TIME (min)
The Princess Diaries	115	How the Grinch Stole Christmas	105
Air Bud	93	Shrek	93
101 Dalmatians	103	Spy Kids	88
Aladdin	90	Cats & Dogs	87
Annie	90	Harry Potter & the Sorcerer's Stone	152
Alice in Wonderland	75	Free Willy	112
The Little Mermaid	83	Flubber	94
Hercules	83	Snow Day	90
Dumbo	64	The Sand Lot	101
The Wizard of Oz	143	D2 The Might Ducks	107
Toy Story 1	81	Crocodile Dundee in LA	94
Pocahontas	81	My Girl	102
The Powerpuff Girls	74	Snow Dogs	99
The Jungle Book	78		

Steps to construct a box-and-whisker plot for the running time.

- Order the data from least to greatest.
- Identify the lower extreme and the upper extreme. LE _____ UE _____
- Identify the median. Median _____
- Identify the lower quartile and upper quartile. LQ _____ UQ _____
- Use the lower and upper extremes to construct an appropriate number line.
The number line must include the two extremes and count by a consistent interval.
- Place data points above the number line for each of the identified points.
- Draw a box from the lower quartile to the upper quartile.
- Draw a vertical line through the median point.
- Draw whiskers from the quartiles out to the two extreme values.
- Title your box-and-whisker plot.

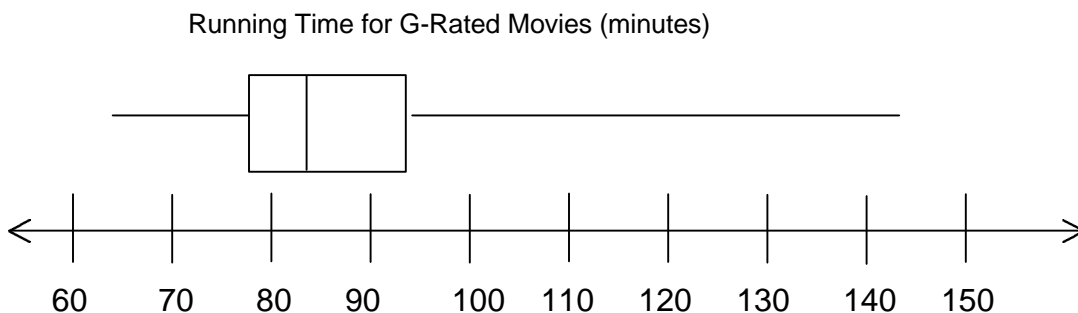


IT'S SHOW TIME ANSWER KEY
Constructing Box-and-Whisker Plots

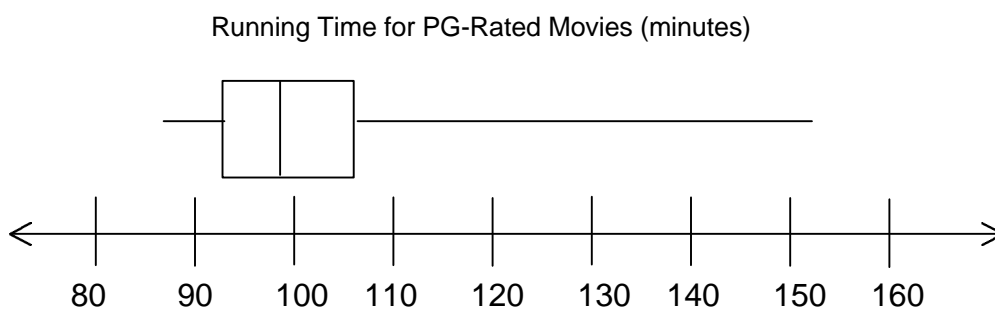
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Steps to construct a box-and-whisker plot for the running time.

- Order the data from least to greatest.
64, 74, 75, 78, 81, 81, 83, 83, 90, 90, 93, 103, 115, 143
- Identify the lower extreme and the upper extreme. LE **64** UE **143**
- Identify the median. Median **83**
- Identify the lower quartile and upper quartile. LQ **78** UQ **93**
- Use the lower and upper extremes to construct an appropriate number line. The number line must include the two extremes and count by a consistent interval.
- Place data points above the number line for each of the identified points.
- Draw a box from the lower quartile to the upper quartile.
- Draw a vertical line through the median point.
- Draw whiskers from the quartiles out to the two extreme values.
- Title your box-and-whisker plot.



Lower Extreme: 87
Upper Extreme: 152
Median: 99
Lower Quartile: 91.5
Upper Quartile: 106



Box-and-Whisker Plot Directions for the TI-83 Graphing Calculator

GETTING THE CALCULATOR READY

- 1) Press **MODE**.
- 2) Make sure that all the left hand side is highlighted (NORMAL, FLOAT, Radian, FUNC, CONNECTED SEQUENTIAL, FULL SCREEN).
- 3) Press **Y=**.
- 4) Turn off plots by pressing **2nd** **y=** **4** **ENTER**.

ENTERING DATA IN LISTS

- 1) Press **STAT** **ENTER**.
- 2) Clear existing lists by pressing **▲** **CLEAR** **ENTER**.
- 3) Arrow over to L2 and repeat the above steps.
- 4) Arrow back to L1 and enter the data (information).

DRAWING A BOX-AND-WHISKER PLOT

- 1) Press **2ND** **Y=**.
- 2) Go to plot 1 and press **ENTER**.
- 3) Turn on plot 1 by highlighting ON and pressing **ENTER**.
- 4) Turn on whisker plot by arrowing down to TYPE. Place the cursor over the fifth diagram and press **ENTER**.
- 5) Arrow down to Xlist and highlight L1. Press **ENTER**.
- 6) Arrow down to Freq and highlight 1. Press **ENTER**.

DRAWING A SECOND BOX-AND-WHISKER PLOT

- 1) Enter data into L2.
- 2) Turn on plot 2.
- 3) Arrow down to Xlist. Press **2nd** **2** to write L2.

SETTING YOUR WINDOW TO DISPLAY YOUR GRAPH(S).

- 1) Press **WINDOW**.
- 2) Arrow down to Xmin and press 0.
- 3) Arrow down to Xmax and place in an appropriate maximum for your data.
- 4) Arrow down to Xscl and press 1.
- 5) Arrow down to Ymin and press 0.
- 6) Arrow down to Ymax and press 10.
- 7) Arrow down to Yscl and press 1.

Press **GRAPH** to create the graph.

AND THE WINNER IS . . .

For the first time in history two African-Americans won best actor and actress at the Oscars on March 25, 2002. Denzel Washington was 47 years old when he won this Oscar and Halle Berry was 33 years old. Below is a stem-and-leaf plot showing the ages of 72 recent Oscar-winners.

Ages of Oscar-Winners

Actresses		Actors
8766641	2	
98775554444331100	3	122235677899
942111	4	00122334556788
0	5	13566
110	6	0012
4	7	6
0	8	

Key: 1|2 = 21 year old actress

3|1 = 31 year old actor

Activity 1 (3 points)

- Find the 3 measures of central tendency and the 2 measures of variation for the ages of the 36 actresses. Round all measures to the nearest tenth.
- Now find the 3 measures of central tendency and the 2 measures of variation for the ages of the 36 actors. Round all measures to the nearest tenth.

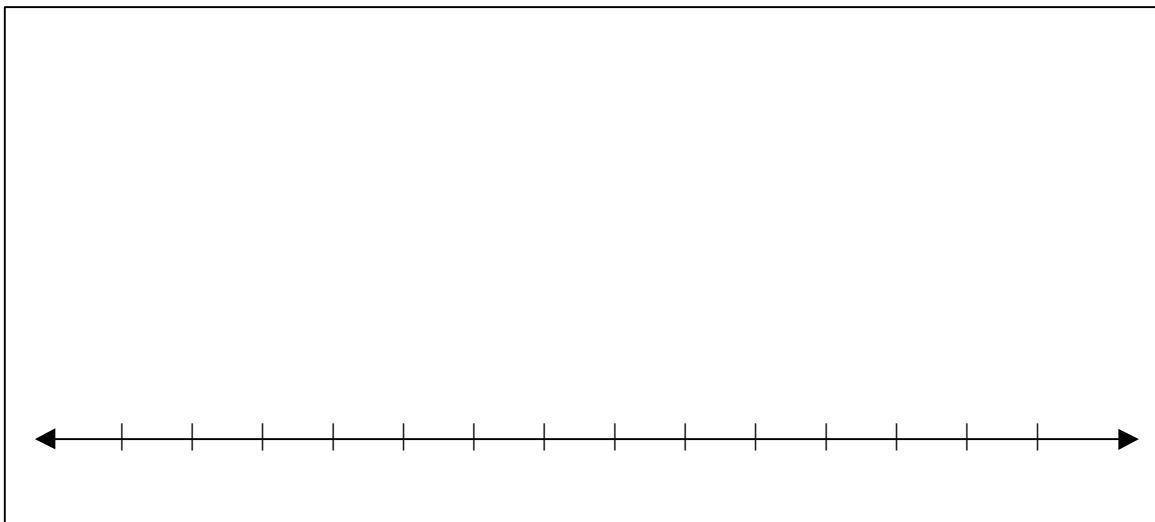
Name _____

Activity 2 (2 points)

- Use the measures of central tendency and variation you just found to write a paragraph comparing the two sets of data.

Activity 3 (3 points)

- Construct a double box-and-whisker plot of the data for the ages of Oscar-winning actors and actresses in the box below.



Name _____

Activity 4 (2 points)

- Determine the typical age of an Oscar-winning actress. Now do the same for an Oscar-winning actor. Use the box-and-whisker plot and the measures of central tendency to support your generalization.

And the Winner Is ...
Scoring Tool

Activity 1

Actresses	Mean – 38.9
	Median – 35
	Mode – 34
	Range – 59
	Interquartile Range – 11
Actors	Mean – 45.1
	Median – 43
	Mode – 32
	Range – 45
	Interquartile Range – 14.5

Response to this activity demonstrates the understanding of the measures of central tendency and variation and the ability to calculate the measures.

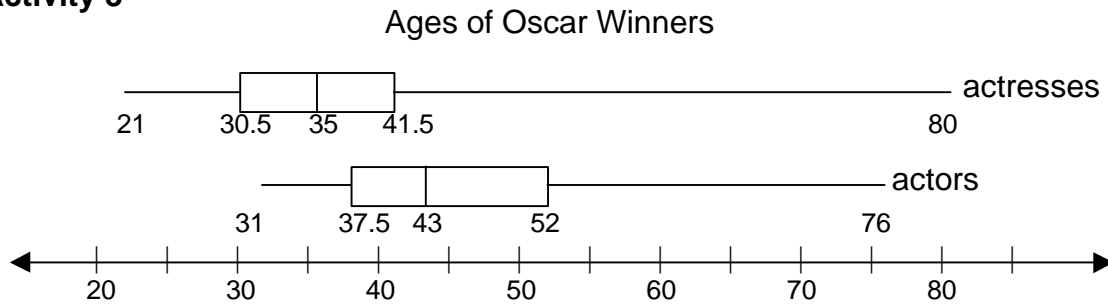
- 3** Students calculate 8 to 10 measures correctly.
- 2** Students calculate 6 or 7 measures correctly.
- 1** Students calculate 4 or 5 measures correctly.
- 0** Students calculate less than 4 measures correctly.

Activity 2

Response to this activity demonstrates the ability to compare two sets of data and express ideas using mathematical vocabulary.

- 2** Students compare the two sets of data using at least two measures of central tendency and one measure of variation. Comparisons include similarities and differences. The explanation is fully developed and clearly presented using the numbers represented by the measures found in activity 1.
- 1** Students compare the two sets of data using at least one measure of central tendency and one measure of variation. Comparisons may include similarities and/or differences. The explanation may not be well developed.
- 0** Students compare one or no measure.
Response is incorrect or off task.

Activity 3



Components of a box-and-whisker plot:

1. Five number summary
 - A. Lower extreme correctly plotted
 - B. Lower quartile correctly plotted
 - C. Median correctly plotted
 - D. Upper quartile correctly plotted
 - E. Upper extreme correctly plotted
2. Title
3. Labels for each box-and-whisker
3. Rectangular box with whiskers correctly constructed.
4. Number line with appropriate intervals

Response to this activity demonstrates the ability to construct a double box-and-whisker plot.

- 3** Students construct both box-and-whisker plots with 2 or fewer errors.
- 2** Students construct both box-and-whisker plots with 3 to 4 errors.
- 1** Students construct both box-and-whisker plots with 5 to 6 errors.
- 0** Students construct both box-and-whisker plots with 6 or more errors or response is off task.

Activity 4

Response to this activity demonstrates the ability to analyze measures of central tendency to determine the typical age of an Oscar-winning actresses and actor.

- 2** Students correctly determine the typical age of both the Oscar winning actress (35) and actor (43) using the median. The decision is fully justified and may mention the presence of outliers.
- 1** Students correctly determine the typical age of both the Oscar winning actress and actor using the median. The decision is not fully justified.
OR
Students chose a different measure of central tendency and fully supported their response.
- 0** Any other response.